BBI Compensation for CESR-c

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I. 8x3 vs 8x5

Beta blowup calculated to be worse for 8x5 than 8x3 at the same bunch current. Level of distortion at 2 mA in 8x5 occurs at 3.4 mA in 8x3. On this basis, using a scaling power of 1.3, calculated a potential 20% increase in luminosity.

II. Optimize for operating current

Constrain optics at operating bunch current rather than at zero current. De-optimization at lower current less important, since BBI effects weaker there. Implementation of this suggestion non-trivial, developed by DLR and MJF in e+/e- symmetric way. Optics now bunch-dependent. Chose to optimize for bunch 3 in 9x5.
The calculated dynamic aperture is larger at the optimal bunch current than at zero current for the design pretzel amplitude, but not for the lower pretzel amplitude used during operation.
MGB idea:

- Design closed phase correction knobs around each set of parasitic crossings.
- Correct tunes, beta sine and cosine components for H and V (6 quantities)
- Use 8 quads for the 6 quantities, sharing 4 end quads with neighboring sets.
- 6 knobs for each of 18 sets of crossings: 108 knobs.
- Implement ability to scale the knob strengths with total beam current.

The correction is specific to a given bunch, since the pattern of crossings is different for each bunch. Chose train 1 bunch 2 for an 8x3 configuration. The correction is not exact within the region of 8 quads.

While these design criteria are derived from the closed orbit optics, they directly address the tails by reducing the resonant distortion associated with operating near the half-integer tune.

Operationally one may expect performance to be more sensitive to the horizontal corrections.
I. Recognized need for IP compensation due to injecting into collision (3/23)
   A. Original design inspired by injection current limit of weak into strong beam
   B. Use of closed beta bumps preserves optics outside IP

II. Optimized IP knob coefficients using tunes and EXFR PB lifetime
   A. Knobs 1 and 2: Tune tracker
   B. Knobs 3-6: Use of closed pulsed bump preserves collision and IP optics, but ...
   C. ... tests aperture only at 28E and 34E

III. Superpose IP and LRBBI coefficients; find current limit
   A. 8x3 90 mA ➔ 105 mA (3/23)
   B. 8x4 120 mA ➔ 132 mA (4/5, JTH later increased to 145 mA)
Local BBI compensation allows higher bunch current at lower pretzel amplitude.

We have a model!
Increase the positron bunch current in the simulation of the local BBI compensation until the dynamic aperture is restricted at the level obtained at a bunch current of 4 mA by Qtuning.

This limit is reached at 6 mA rather than 4 mA, indicating an increase of 50% in current over present operating conditions may be possible.
I. Most of the work is done!

   A. Lattice design incorporates LR BBI (DLR/MJF)
   B. Closed BBI knobs defined, optimized, implemented (major effort – MGB)
   C. Effectiveness modelled (JAC) and demonstrated (JAC/MGB)

II. Some thinking to do about design strategy

   A. Optimize lattice at higher bunch current? 8x3 t1.b2 or 9x5 t1.b3?
   B. Lower design pretzel? (Changes knob coefficients.)
   C. Calculate knob coefficients at what bunch current? (Correlated with above)

III. Improve IP knob coefficient tuning by using both E and W bumps

IV. Empirical tuning of knob strengths at operating current

V. Develop operating procedure